ARMY MEDICAL RESEARCH LABORATORY

FORT KNOX, KENTUCKY

REPORT NO. 62
3 September 1951

AN AID TO ACCURACY IN ROENTGENOGRAPHY*

*Sub-project under Studies of Body Measurements as They Affect Physiological Efficiency. Approved 31 May 1946. AMRL Project No. 6-64-12-05-(6).

MEDICAL RESEARCH AND DEVELOPMENT BOARD
OFFICE OF THE SURGEON GENERAL
DEPARTMENT OF THE ARMY

UNCLASSIFIED

ATI 139 078 (COPIES OBTAINABLE FROM ASTIA-DSC)

ARMY MEDICAL RESEARCH LAB., FORT KNOX, KY (REPORT NO. 62)

AN AID TO ACCURACY IN ROENTGENOGRAPHY - PROJECT NO. 6-64-12-05-(6)

CARPENTER, ARTHUR 3 SEPT '51 13PP PHOTOS, DIAGRS

RADIOLOGY, X-RAY
ALIGNMENT METHODS

MEDICINE (19)
ROENTGENOLOGY (6)

UNCLASSIFIED

REPORT NO. 62

AN AID TO ACCURACY IN ROENTGENOGRAPHY*

By

Arthur Carpenter
Roentgenologic and Photographic Scientist

From

Army Medical Research Laboratory
Fort Knox, Kentucky
3 September 1951

*Sub-project under Studies of Body Measurements as They Affect Physiological Efficiency. Approved 31 May 1946. AMRL Project No. 6-64-12-05-(6).

Report No. 62 3 September 1951
Project No. 6-64-12-05-(6)
MEDEA

ABSTRACT

AN AID TO ACCURACY IN ROENTGENOGRAPHY

OBJECT

For laboratory research purposes in roentgenography, as well as for the maintenance of high quality in routine clinical radiography, it is always desirable that the orientations and mutual alignments of x-ray tube, patient, and film, be of high precision and known accuracy.

The object of this study was to determine the customary degrees of accuracy of conventional radiographic alignments and to develop a remedy for any significant inaccuracies discovered.

RESULTS

Studies of the operating efficiency of typical professional x-ray technicians disclosed persistent common errors in alignments which are often unnoticed and yet may be sufficient to impair the accuracy of the diagnosis made from the resulting radiograph.

A simple optical attachment for the x-ray tube stand was developed which eliminates alignment errors by permitting the operating technician to sight along the axis of the x-ray beam without in any way interfering with the beam or limiting its range of adjustment. The attachment is adaptable to either fixed x-ray units or portable field type equipment.

CONCLUSION

The optical attachment here described is simple to install and comparatively inexpensive. Used in conjunction with the usual scales and divided circles of conventional x-ray apparatus it permits complete accuracy of orientation and alignment for ordinary clinical as well as laboratory research radiography. It is of particular interest when accurate radiographs of extremeties or small areas are desired, and is likewise especially convenient in antrum, sinus, and other head radiography.

RECOMMENDATIONS

This optical attachment should be brought to the attention of roentgenologists and x-ray technicians. It would be a simple and desirable attachment for all portable field type units.

Submitted by:
Arthur Carpenter, Roentgenologic
and Photographic Scientist, Chief
X-Ray and Photographic Section

Approved by: Ray G. Daggs
RAY G. DAGGS
Director of Research

Approved by: Carl F. Tessmer
CARL F. TESSMER
Lt. Col., MC
Commanding

AN AID TO ACCURACY IN ROENTGENOGRAPHY

I. INTRODUCTION

Skill in the performance of a mechanical operation which involves apperceptive judgement is an acquired art. Initially such skill improves with repetition of the operation until it finally reaches a level of equilibrium between the operator's dexterity, his interest, and the sustained frequence of the operation.

It is generally noted that once this learning period is past the individual usually tends to appraise his own skill at a higher level than his actual proficiency warrants. In many fields of skilled endeavor this over-confidence is merely a matter of psychophysiological interest, but there are certain activities in which it may lead to significant errors in the technique or in results.

One such activity is found in radiography--in the matter of establishing exact mutual orientations and alignments between the x-ray tube, the patient, and the film cassette.

Particularly in clinical radiography, accurate diagnosis is predicated upon precise alignments during the making of the radiograph. Modern x-ray apparatus is provided with graduated scales, stops, and divided circles to facilitate the setting of precise orientations. But no amount of scaling will also assure alignment accuracy superior to the apperceptive skill of the x-ray technician.

Nearly all manuals of radiographic technique, including the Army Technical Manual, TM-8-820, on "Military Roentgenography," define precise orientations and alignments for the taking of any conventional radiograph. In some cases these directions require that the x-ray technician discriminate between small alignment angles such as 5° and 10°, and in other cases that he adopt and align angles of odd values such as 17° or 23°. Many thousands of such radiographs are recorded everyday throughout the profession and corresponding thousands of clinical diagnoses are made on the assumption that the taking alignments of the radiographs have been accurately established. Such confidence in the infallibility of the x-ray technician is not always warranted.

II. DETERMINATION OF X-RAY ALIGNMENT ERRORS

Having had occasion to establish, for reserach purposes, radiographic alignments of measured accuracy, apparatus was devised for precisely indicating and recording the actual alignment of any given setting. Through the use of this apparatus it developed that a majority of individuals considerably overestimated their own ability to establish a predesignated radiographic alignment with satisfactory precision.

Several groups of individuals of different levels of training ranging from professional x-ray technicians through laboratory technicians to high level scientific research personnel, were surveyed and appraised.

Each subject was asked to make a series of typical radiographic settings on a regulation hospital type radiographic unit. All settings were made at a uniform tube distance of 30" but the series included both simple and compound orientations and alignments. After each setting, its accuracy was recorded mechanically on a graph sheet which showed the extent and direction of any angular deviation from the specified settings.

Typical of the results obtained are those shown in the first two figures which are recordings of a simple and a compound setting as performed by fourteen professional x-ray technicians, each actively engaged in radiography for the past five years or more.

Figure 1 shows the results when these professional technicians undertook to align the x-ray tube vertically over the center of a 10" x 12" film cassette at a tube heighth of 30".

Figure 2 shows the results when the same individuals undertook to incline the tube 5° laterally, 20° longitudinally, and then align the axis of the x-ray beam with the center of the 10" x 12" film cassette.

Each of these tests involved only the alignment of the tube with the cassette, and they were all made without the complication of the usual third element of a setting, namely, the patient.

Acceptable accuracy would have resulted in the dots all falling within the small tolerance circle surrounding the bullseye (1°).

Prior to the tests each of these professional x-ray technicians expressed full confidence in his own ability to make accurate radiographic alignments without instrumental aids other than the normal graduations of the apparatus.

III. OPTICAL ALIGNMENT

Having demonstrated by a number of tests on several individuals that actual skill in radiographic alignment usually falls far short of presumed skill a number of devices intended to obviate the element of personal judgment were constructed and tested.

The simplest and most accurate device so far tried, and the one currently used in this laboratory, is the optical sighting element here described. It consists of a war surplus aerial gunsight and a small area of front surface mirror coated on a sheet of 1/16" thick Lucite. Its construction entails little work and costs less than ten dollars.

Since World War II various salvage and war surplus dealers have sold aerial gunsight elements containing target reticles. These reticles appear to be projected forward axially into space when viewed through the element. Such elements are relatively inexpensive, the ones shown in the accompanying illustrations having been obtained from a salvage dealer at a cost of about one dollar. One such reticle projecting eyepiece is mounted at the distal end of the x-ray tube carriage support arm in such a position that its optical axis is parallel to the tube slide and intersects the axis of the x-ray beam in any position of the tube. If the x-ray tube is used without a

cone or tube then a fitting of plywood or plastic is fashioned to fit the cone slide and support a front surface lucite mirror at a position normal to the bisect of the angle between the axis of the eyepiece and the axis of the x-ray beam when the tube is vertical. Stated more simply, the mirror is supported at an angle of 45° in front of the eyepiece so that the line of sight of the eyepiece is deflected downward along the axis of the x-ray beam.

This laboratory made its own lucite mirrors by evaporating a film of aluminum onto a sheet of thin clear lucite in a vacuum chamber. However, such reflectors may be obtained inexpensively from a number of firms that advertise evaporation metalizing of reflectors for amateur telescope makers.

The arrangement described above is diagrammed in Figure 3 (B) and is shown in use in Figure 4.

If the tube is inclined in any azimuth the line of sight remains satisfactorily axial to the x-ray beam through the useful ranges of deflection. To assure that axial deviation be as small as possible even at high transverse inclinations it is desirable to have the eyepiece mounted as close to the horizontal plane through the pivots of the tube mount as possible.

If a cone or spot tube is used the lucite mirror may be rigidly positioned in the attachment and an elongated hole opened in the side toward the eyepiece without impairing the effectiveness of the attachment. Such a mounting is indicated in Figure 3 (A).

The 1/16" thick lucite mirror across the x-ray beam interposes no significant obstacle to the beam and does not require any exposure compensation.

When the x-ray technician sights through the eyepiece he sees the entire operating field with the reticle target apparently projected onto the subject or into the plane of the cassette. The appearance of the operating field through the eyepiece, in the alignment pictured in Figure 4 is shown in Figure 5.

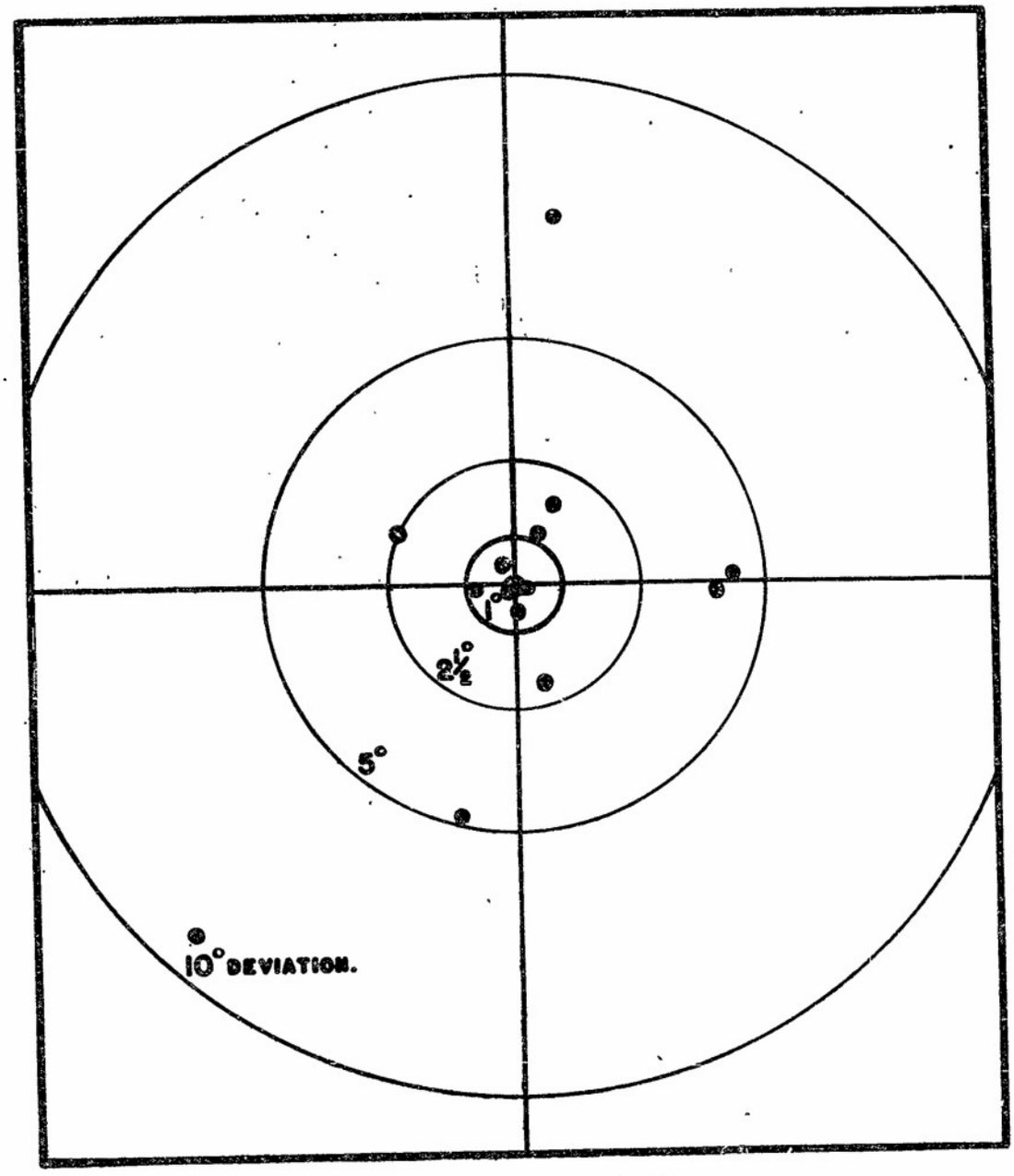
As the tube is shifted about or inclined, or when the subject or cassette is moved about on the table, the target appears to drift correspondingly about the field. Whatever point of the operating field appears to coincide with the bullseye of the target, that point is the surface intercept of the x-ray axis. If a cassette bearing crossed center lines is used, and the intersection of the lines is centered on the target, then the x-ray axis is accurately aligned with the cassette, regardless of the orientation of the tube.

At this laboratory, for extra precise work, it is the custom to mark the desired subject intercept with a spot sticker. These spot stickers are prepared by blackening ordinary gummed reinforcements for the holes in loose-leaf notebook sheets with Higgens' waterproof black drafting ink. The desired tube orientation is then established and locked, and the x-ray beam axis is optically aligned on the center of the cassette. Finally the marked patient is moved into alignment, optically positioned, and the exposure made.

This optical attachment is easily applied to x-ray units of the portable and field types in which the tube heads are mounted at the end of an extensible arm instead of on a tube slide. On such units the sighting device becomes an integral part of the detachable cone and may be used or removed at will. Such an optically equipped cone is diagrammed in Figure 3 (C) and shown in operation on a standard Army Field Type X-Ray Unit in Figures 6 and 7.

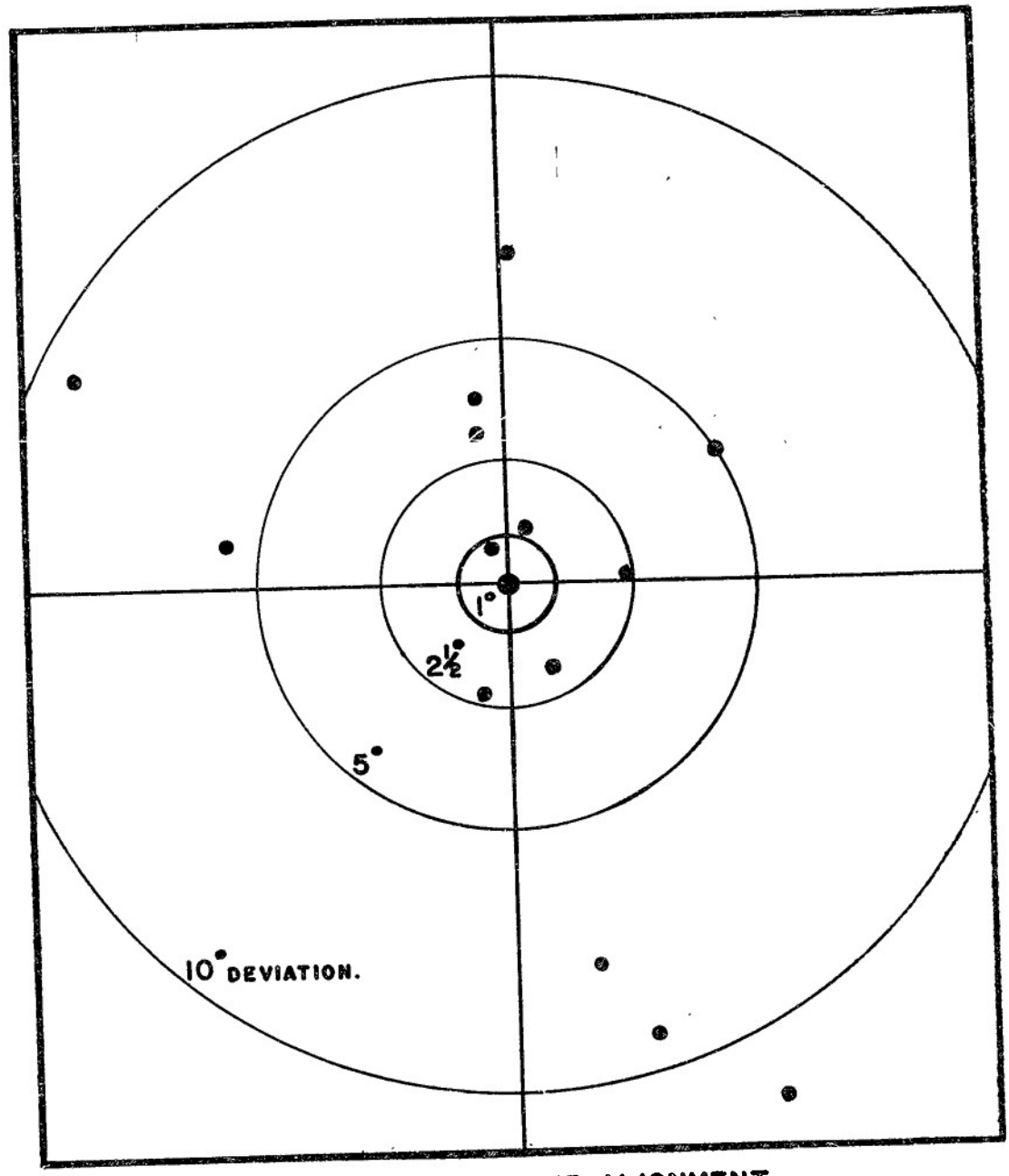
IV. CONCLUSIONS

With the optical attachment herein described even an inexperienced assistant can establish predesignated radiographic orientations with satisfactory accuracy, and an experienced roentgenographer can both maintain uniform high accuracy of alignment and considerably expidite his routine quantity radiography.



VERTICAL ALIGNMENT.

FIGURE 1.



COMPOUND OBLIQUE ALIGNMENT.

FIGURE 2.

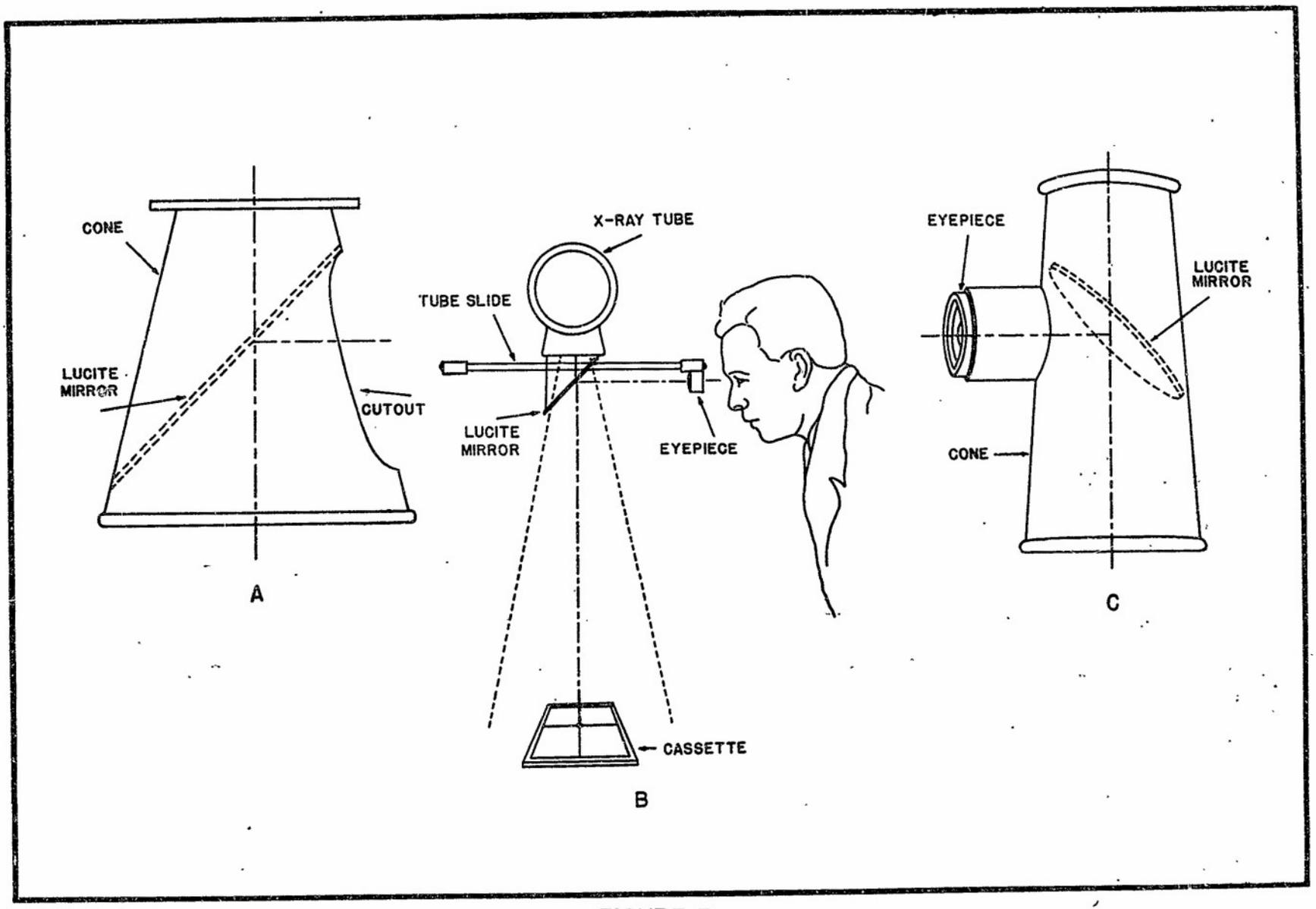

CONE
LUCITE MIRROR
CUTOUT
A
X-RAY TUBE
TUBE SLIDE
LUCITE MIRROR
EYEPIECE
CASSETTE
B
EYEPIECE
LUCITE MIRROR
CONE
C

FIGURE 3.

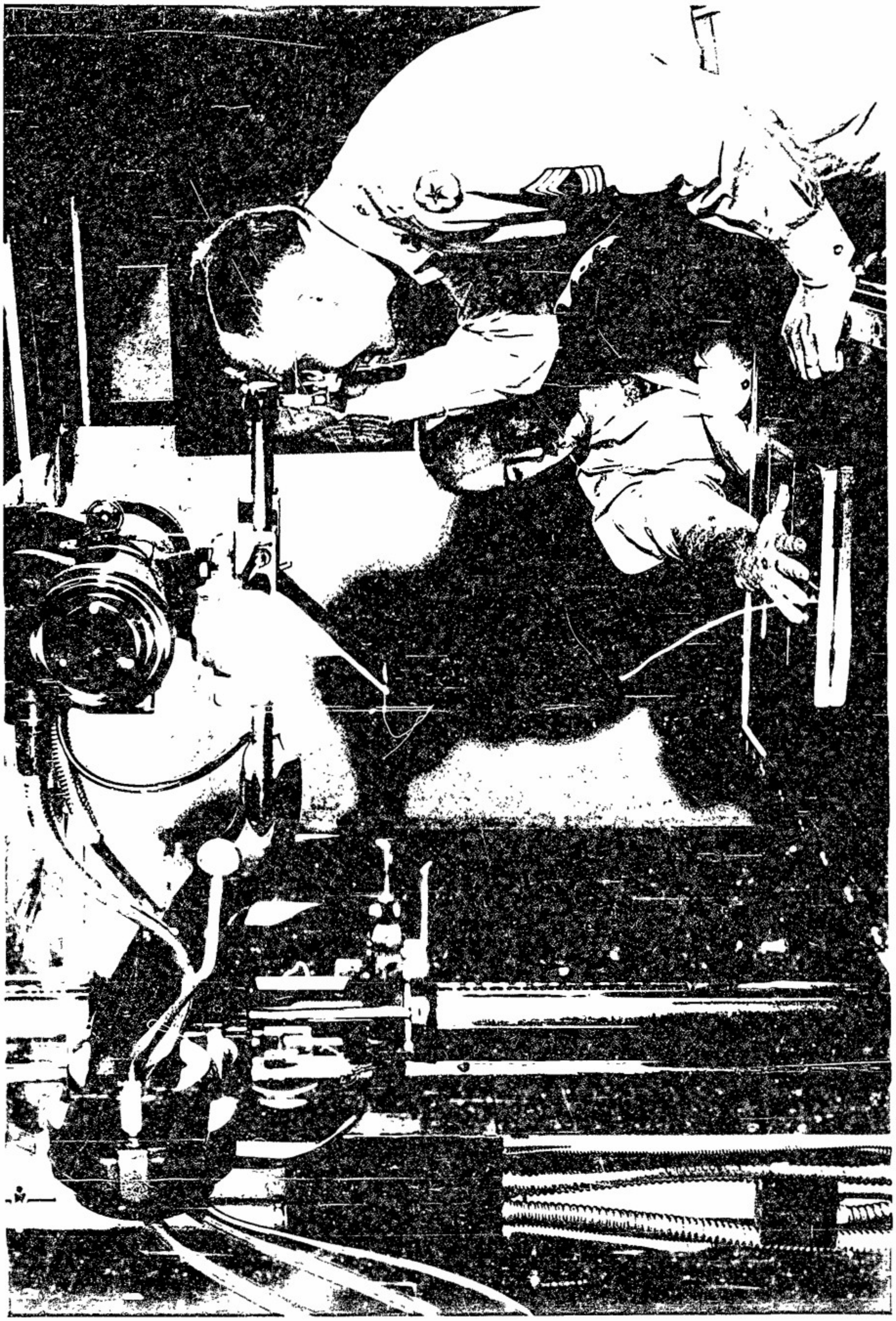


FIGURE 5

FIGURE 6.

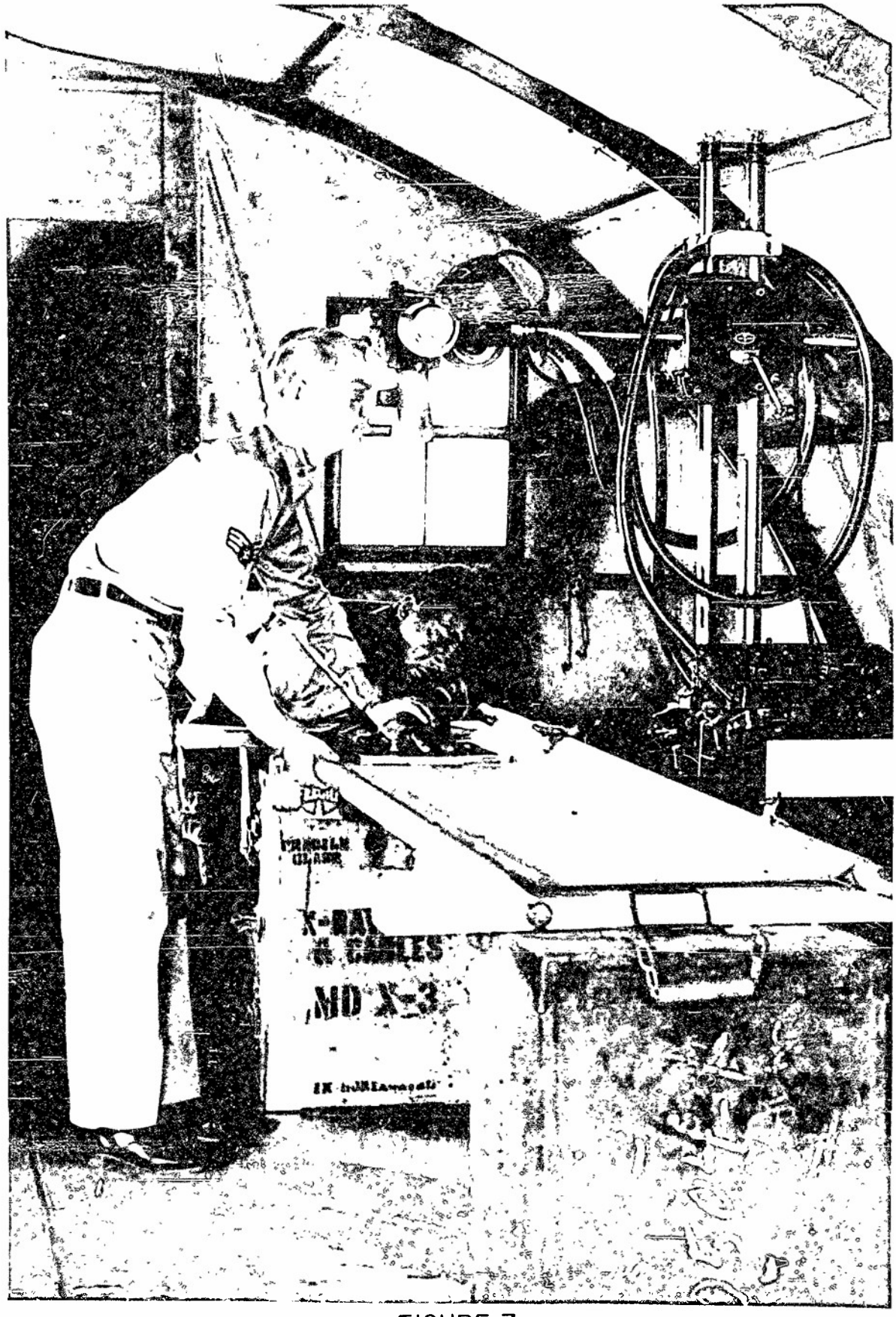


FIGURE 7.